

4.2.9 Target and Horn Support Modules

4.2.9.1 Support module function and specifications

The NuMI target and horn support modules provide mechanical support, cooling water, instrumentation connections and precision alignment capabilities for the production target and magnetic focusing horns in the NuMI target chase. The NuMI beam requires three very similar support modules for (1) the carrier that holds the production target and its upstream baffle, (2) Horn 1 and (3) Horn 2. The intensely radioactive environment of the target chase requires the use of radiation-hard materials and the ability to control, align and service the Target/Baffle and horn assemblies by remote control. Heating caused by the beam and by horn currents places strict requirements on component materials and on cooling to maintain precise alignment. The three support modules are currently in different stages of construction. Horn 1 module: all components have been ordered and most have been delivered. Horn 2 module: all components have been ordered and some have been delivered. Target/Baffle module: all components have been ordered and some have been delivered, including the mainframe.

The most important support module features are:

1. Component materials will maintain alignment and functionality in a corrosive, intensely radioactive environment that is subject to variable heating by the proton beam and horn currents.
2. Modules provide feed-through connections for cooling water, instrumentation cabling, the horn stripline (Horn 1 and 2 modules only) and vacuum (Target/Baffle module only) as required.
3. Modules provide radiation shielding for (beam-off) work by personnel near the feed-through connections at the top of a module and for target hall equipment that cannot be easily removed when the beam is on.
4. The modular design allows failed components to be replaced in the work cell.
5. The mechanical support for a horn or the Target/Baffle carrier can be engaged or disengaged, while the module is in the work cell, using long vertical drawbars that are operated from the top of the module. Similarly, water, electrical and vacuum lines can be connected or disconnected from a horn or the Target/Baffle carrier from the top of a module in the work cell.
6. Modules provide precise, remotely controlled motion of the target and baffle assemblies and of Horn 1 transverse to the beamline, and of the target and baffle along the beamline (e.g., to insert the target into Horn 1 for low energy running).

These design features are accomplished by constructing each module from an open box-like steel structure, the module mainframe, and by independently supporting the shielding blocks (T blocks) that occupy open space within and adjacent to the mainframe. Most feed-through connections utilize “gun-drilled” holes through the 10-inch thick upstream and downstream end-walls of each module. Engineering design issues and the details of module construction are described in the Engineering Handbook document for each module. A preliminary version of the Horn 1 Module Engineering Handbook has been

prepared by Rafael Silva. Handbooks for the Horn 2 and Target/Baffle modules are being prepared by Rafael and by Ernie Villegas, respectively.

Figure 4.2-25 shows schematically how the Horn 1 module and its T-blocks are supported in the target chase. **Figure 4.2-26** shows the relative locations of the Target/Baffle module, the carrier assembly and the Horn 1 module.

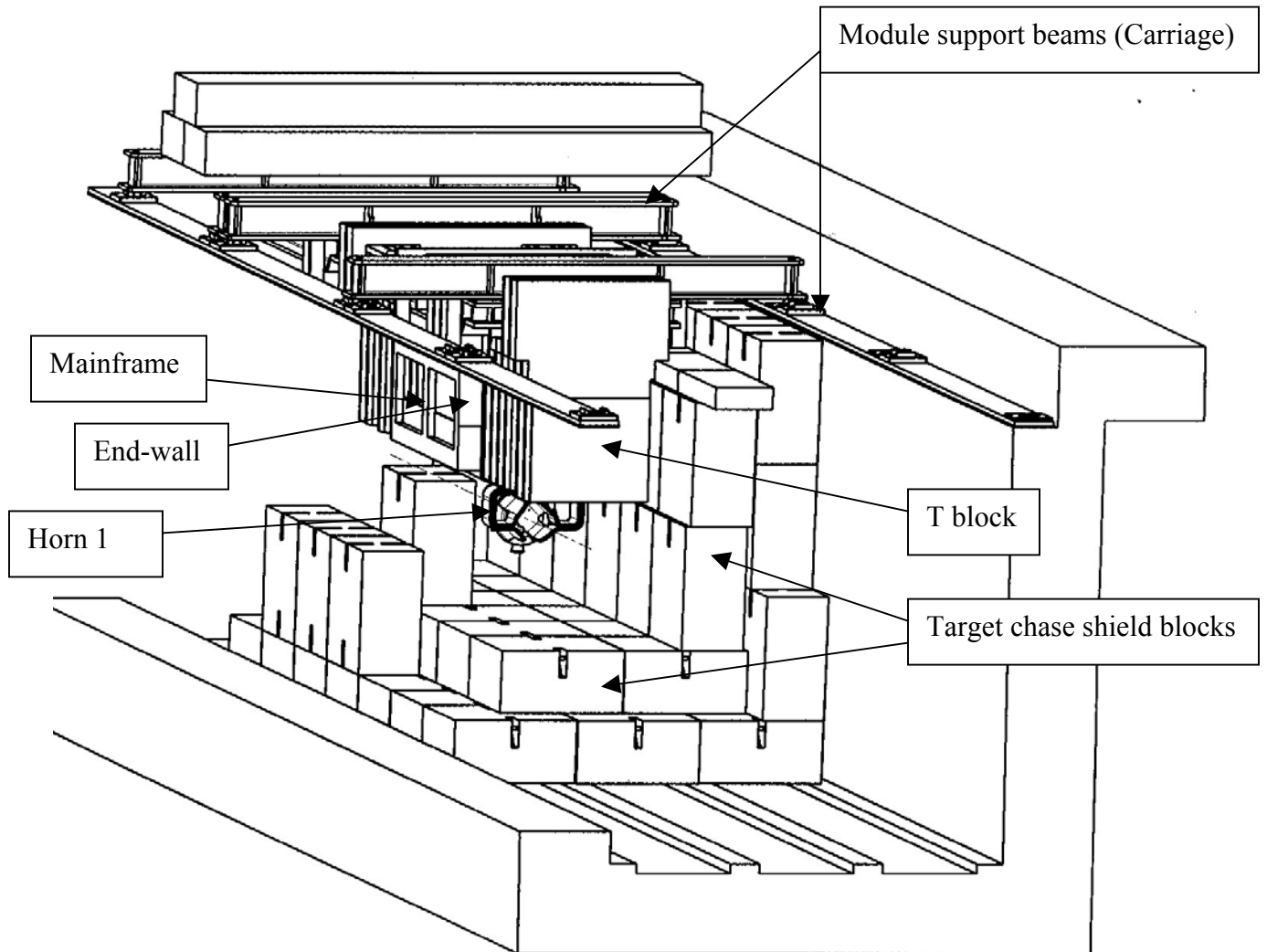


Figure 4.2-25. Schematic representation of the NuMI target chase showing the Horn 1 module and its T-blocks.

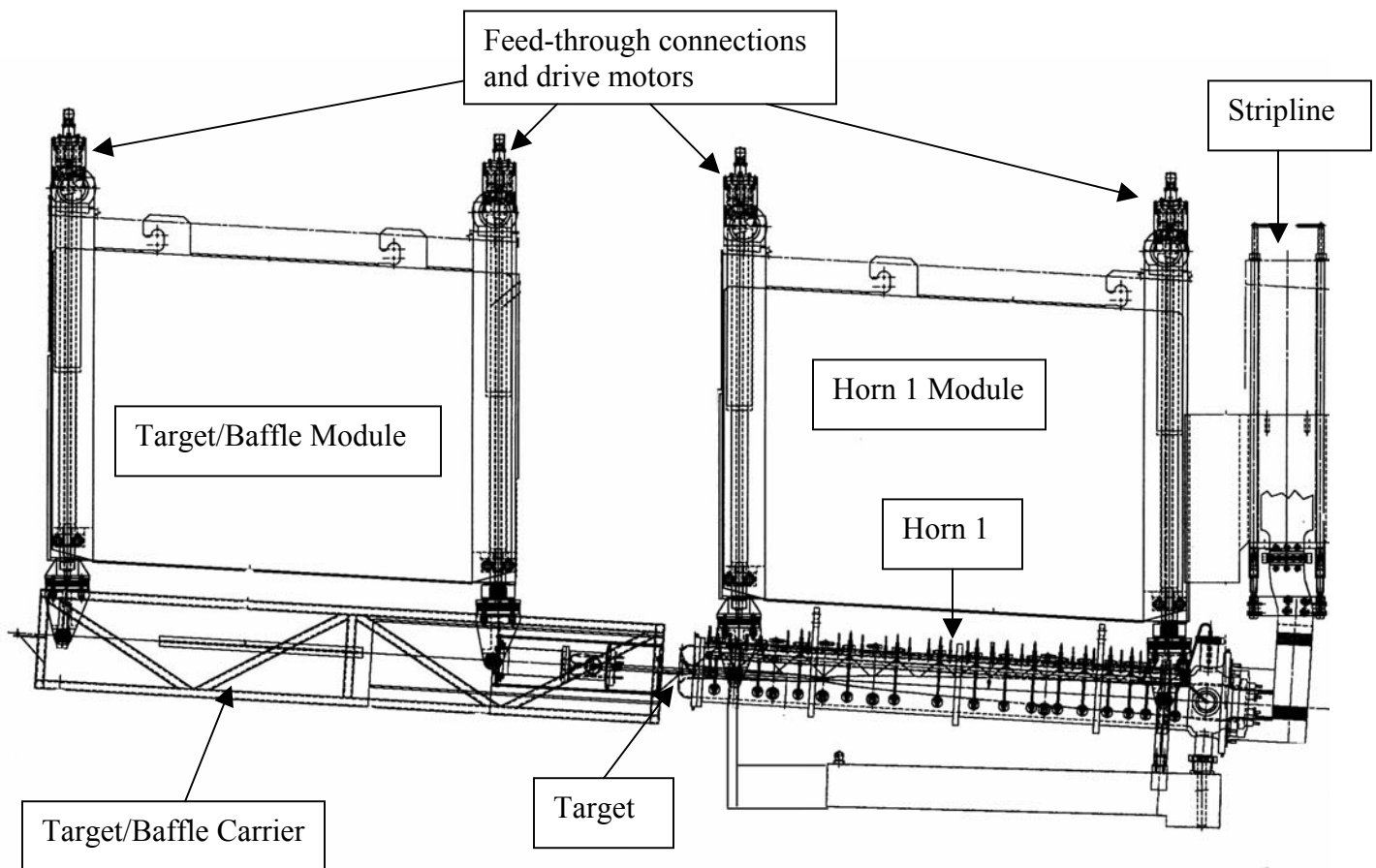


Figure 4.2-26. Schematic representation of the locations of the Target/Baffle and Horn 1 modules, the Target/Baffle carrier and Horn 1.

4.2.9.2. Support module parameters

Each support module consists of the following components:

1. Module mainframe (including stripline support block for Horn 1 and 2 modules).
2. Upstream and downstream supports for a horn or the Target/Baffle carrier.
3. Steel shielding T-blocks that are supported independently of the mainframe.
4. Remotely controlled horizontal and vertical motion (except Horn 2 module).
5. Remotely accessible precision alignment fixtures (tooling balls).
6. Cooling water supply and return connections.
7. Electrical feed-through connections for thermocouples and other instrumentation.
8. Vacuum connections (Target/Baffle module only).

Figures 4.2-27, Figures 4.2-28 and Figures 4.2-29 show some of the construction details of the Horn 1 and Target/Baffle modules. Tables 4.2-14 and 4.2-15 summarize the support module design parameters and alignment tolerances.

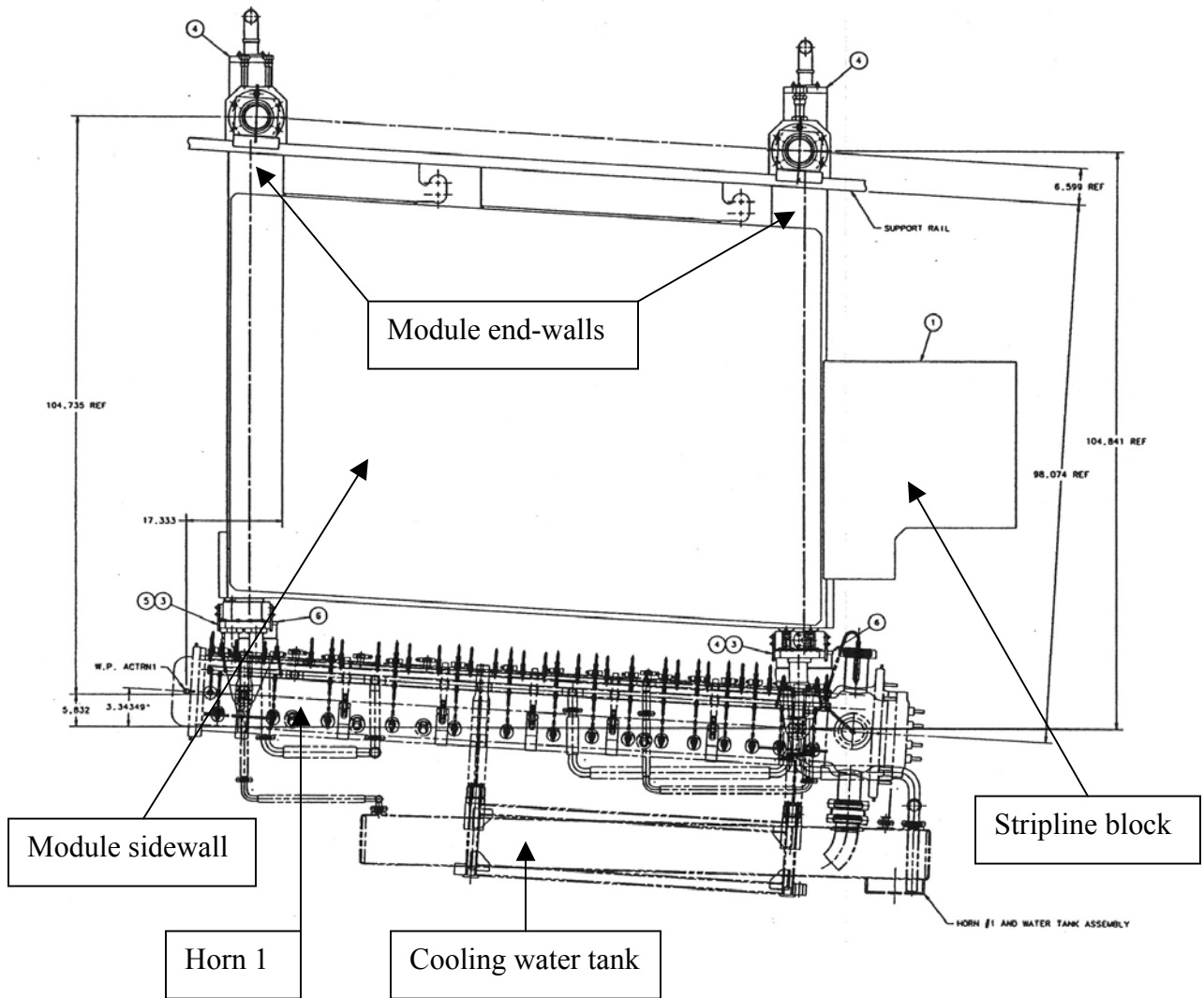


Figure 4.2-27. Side view of the Horn 1 module.

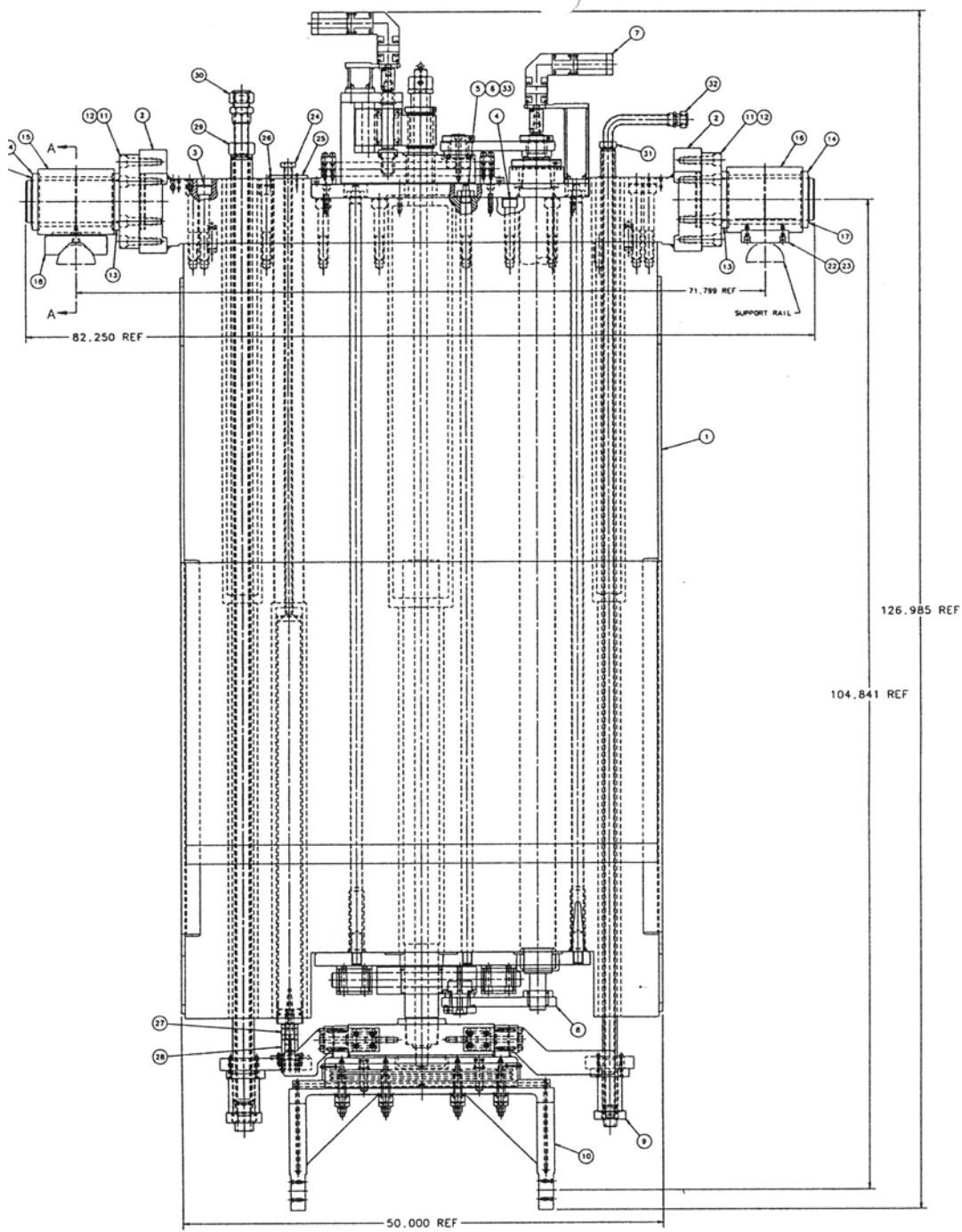


Figure 4.2-28. End view of Horn 1 module end-wall showing drive motors, water and electrical feed-through holes and the penetrations for support drawbars and for making water and electrical connections to Horn 1.

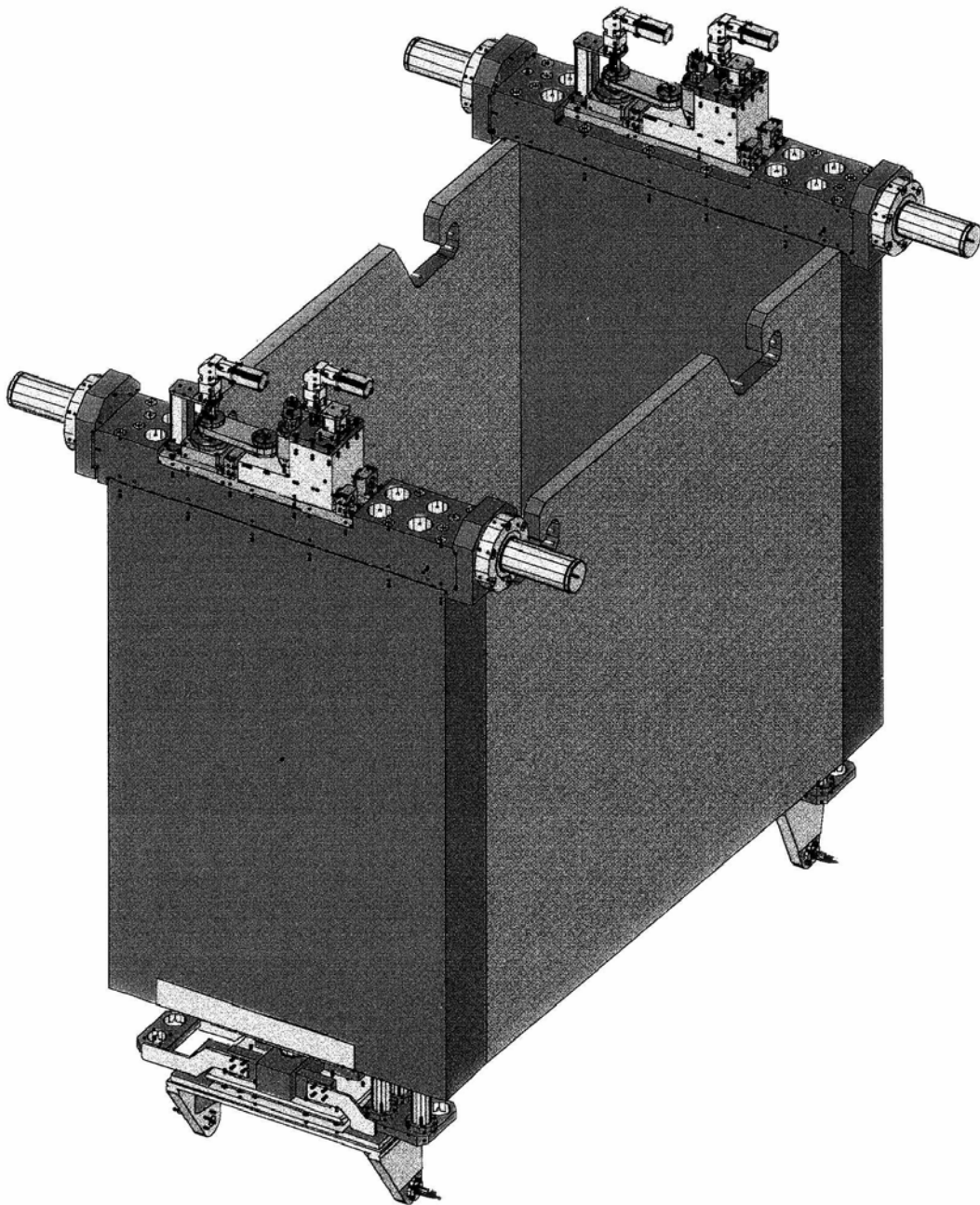


Figure 4.2-29. Isometric drawing of the Target/Baffle module mainframe.

Target/Baffle and Horn Support Module Parameters, November 2002				
Parameter	Horn 1 Module	Horn 2 Module	Target/baffle Module	Comments
Module weight	51,000 lb	~ 51,000 lb	~ 27,200 lb	Total weight (module + component + fixture) limited by 30-ton crane
Component weight (horns, carrier)	1,140 lb	2,120 lb	6,200 lb	Horn weights don't include clamps, stripline
Target chase clearance	2 cm	2 cm	2 cm	Minimum clearance to chase walls
Vertical motion range	+/- 3 mm	Fixed	+ 8 mm to - 200 mm	
Horizontal motion range	+/- 3 mm	Fixed	+/- 8 mm	
Longitudinal motion range	Fixed	Fixed	2.5 m	
Component alignment goal	+/- 0.5 mm	+/- 1.0 mm	+/- 0.5 mm	See Table 2 for details
Design radiation dose - top	10 ⁵ Rad/year	10 ⁵ Rad/year	10 ⁵ Rad/year	
Design radiation dose - bottom	10 ¹¹ Rad/year	10 ¹¹ Rad/year	10 ¹¹ Rad/year	

Table 4.2-14: Summary of current best estimates of support module parameters.

	Target/Baffle	Horn 1	Horn 2
Component alignment goal	+/- 0.5 mm	+/- 0.5 mm	+/- 1 mm
Component motion relative to module			
Motorized vertical range of motion	+8/-200 mm	+/- 3 mm	none
Motorized horizontal range of motion	+/- 8 mm	+/- 3 mm	none
Motorized range of motion along beamline	2500 mm	none	none
Motion due to thermal expansion	<0.5 mm	<0.5mm	~1 mm
Module to Carriage adjustment	None	None	None
Module tolerance	1.5 mm	1.5 mm	1.5 mm
Carriage internal tolerance	1.5 mm	1.5 mm	1.5 mm
Carriage adjustment vertical shim pack	+/- 8mm, 0.8 mm steps	+/- 8mm, 0.8 mm steps	+/- 8 mm, 0.8 mm steps
Carriage adjustment horizontal slip plate	> +/- 8 mm	> +/- 8 mm	> +/- 8 mm
Carriage sag when module put in place*	~ 1.8 mm	~ 1.8 mm	~ 1.8 mm

* Due to the carriage sag under weight we plan to adjust carriage shim pack after module is in place. Displacement due to thermal expansion will tend to be in the downward direction.

Table 4.2-15: Adjustments and tolerances for component positioning in the target hall.